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Beikmann

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(54) **MODULATOR ASSEMBLY FOR CONDENSER**

(71) Applicant: **DENSO International America, Inc.**, Southfield, MI (US)

(72) Inventor: **Aric Beikmann**, Brighton, MI (US)

(73) Assignee: **DENSO International America, Inc.**, Southfield, MI (US)

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F25B 39/04 (2006.01)
F28D 1/00 (2006.01)

(52) **U.S. Cl.**
CPC ***F25B 39/04*** (2013.01); ***F28D 1/00*** (2013.01); *F25B 2339/0446* (2013.01); *F25B 2500/221* (2013.01)

(58) **Field of Classification Search**
CPC F25B 39/04; F25B 2500/221; F25B 2339/0446; F25B 49/02
See application file for complete search history.

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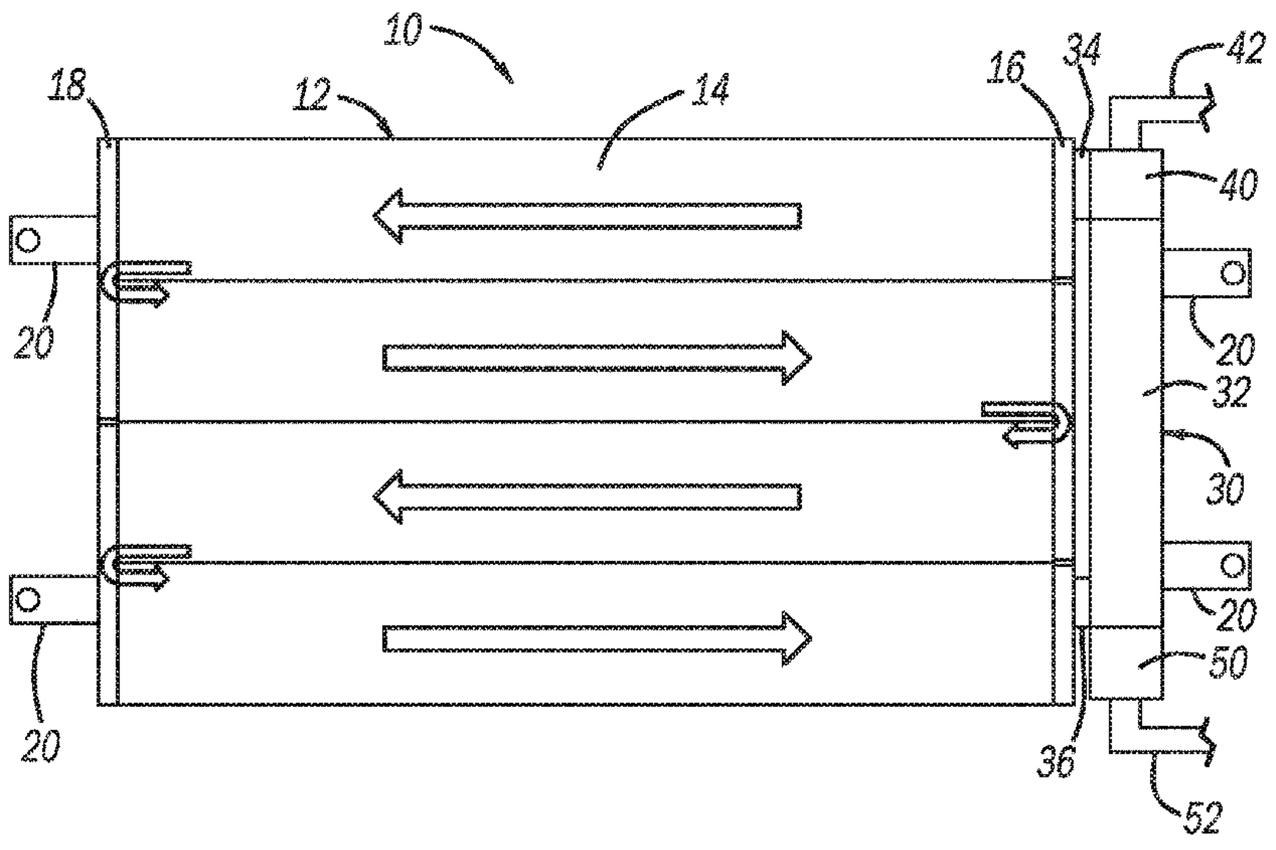
Primary Examiner — Emmanuel E Duke
(74) *Attorney, Agent, or Firm* — Harness, Dickey & Pierce, P.L.C.

(57) **ABSTRACT**

A modulator assembly for a condenser. The modulator assembly has a tube having a first end and a second end. A first connector is brazed to the first end of the tube. A second connector is threadably secured at the second end of the tube.

18 Claims, 3 Drawing Sheets



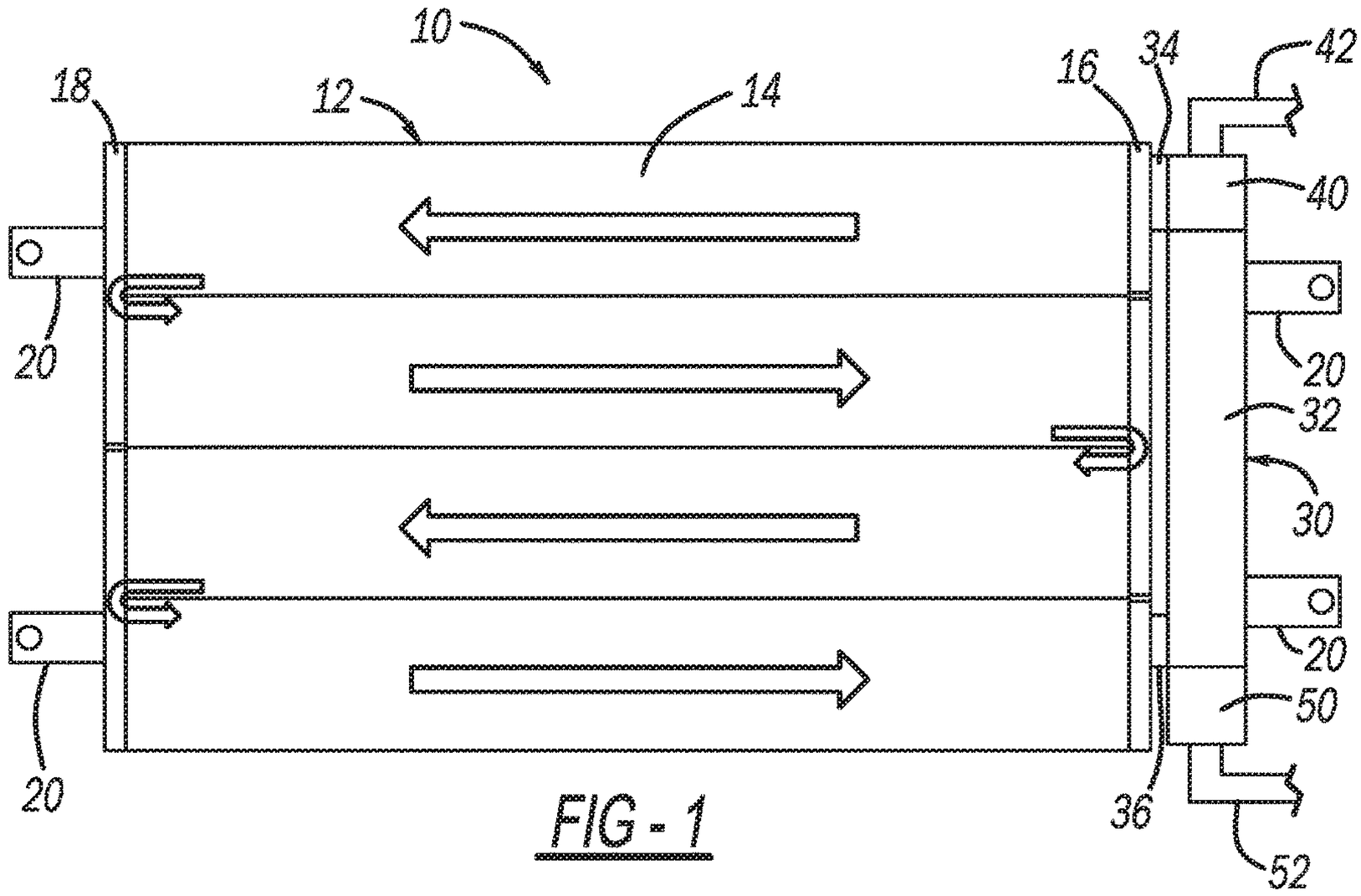

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FIG - 1

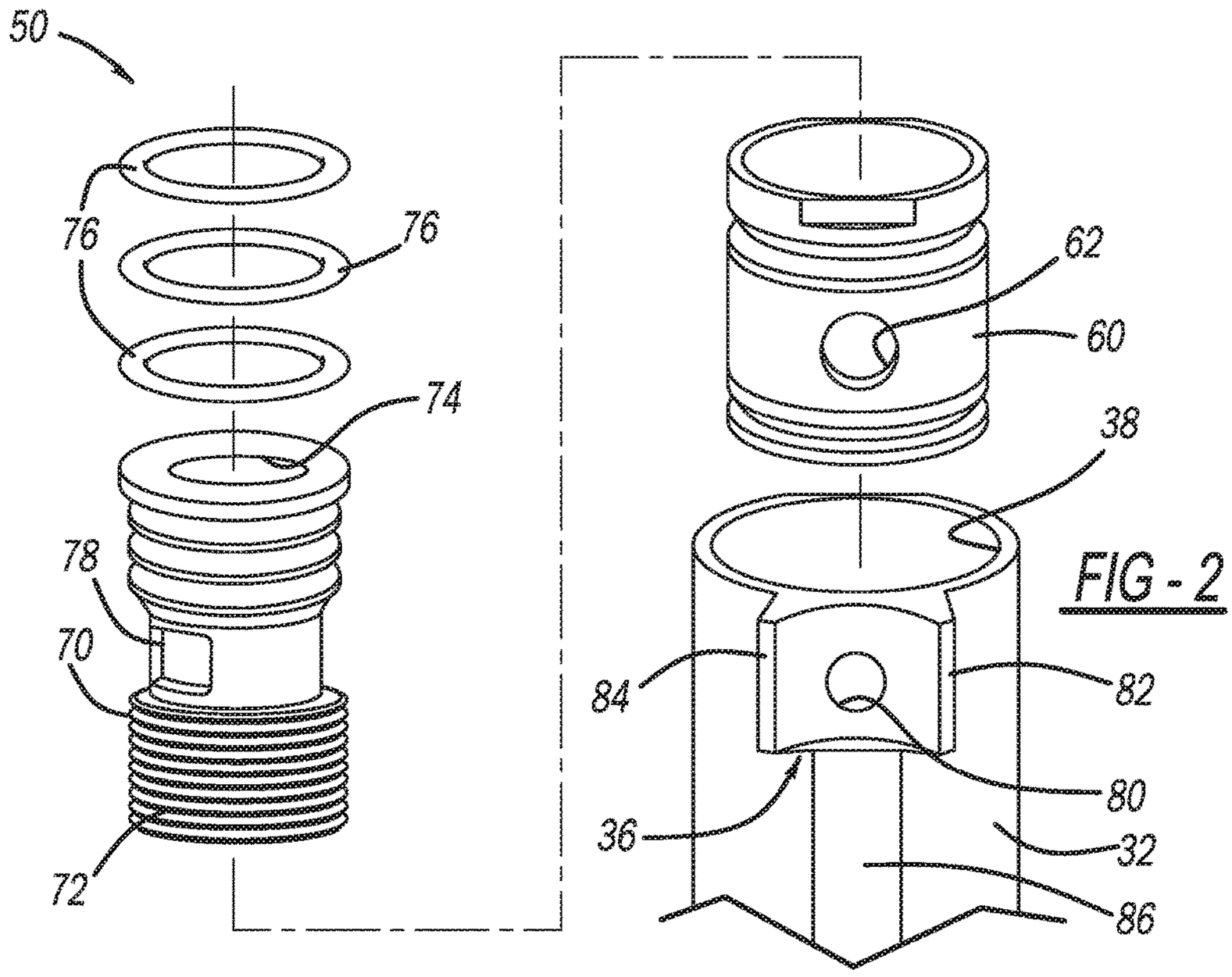
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FIG - 2

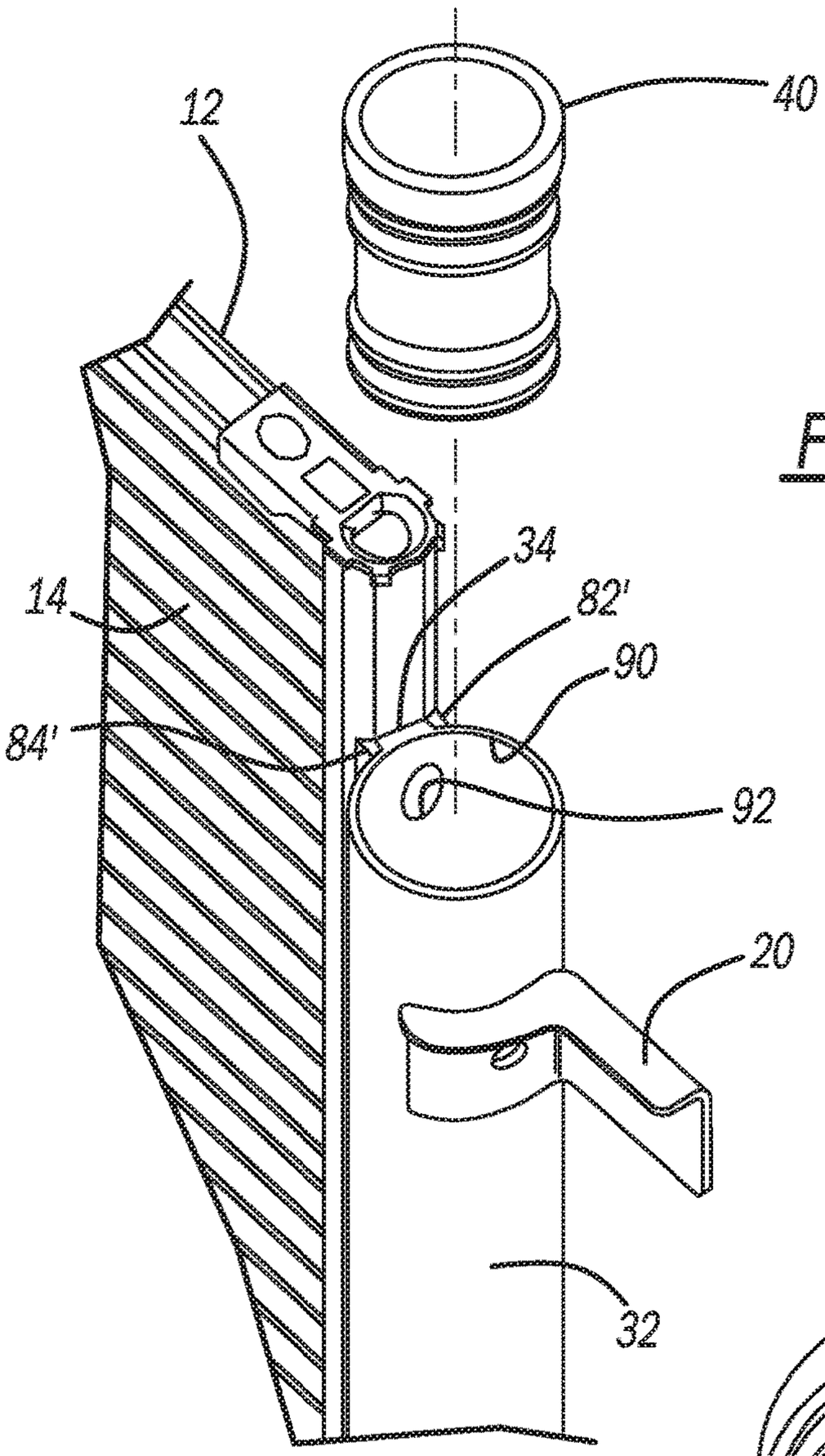

FIG - 3A

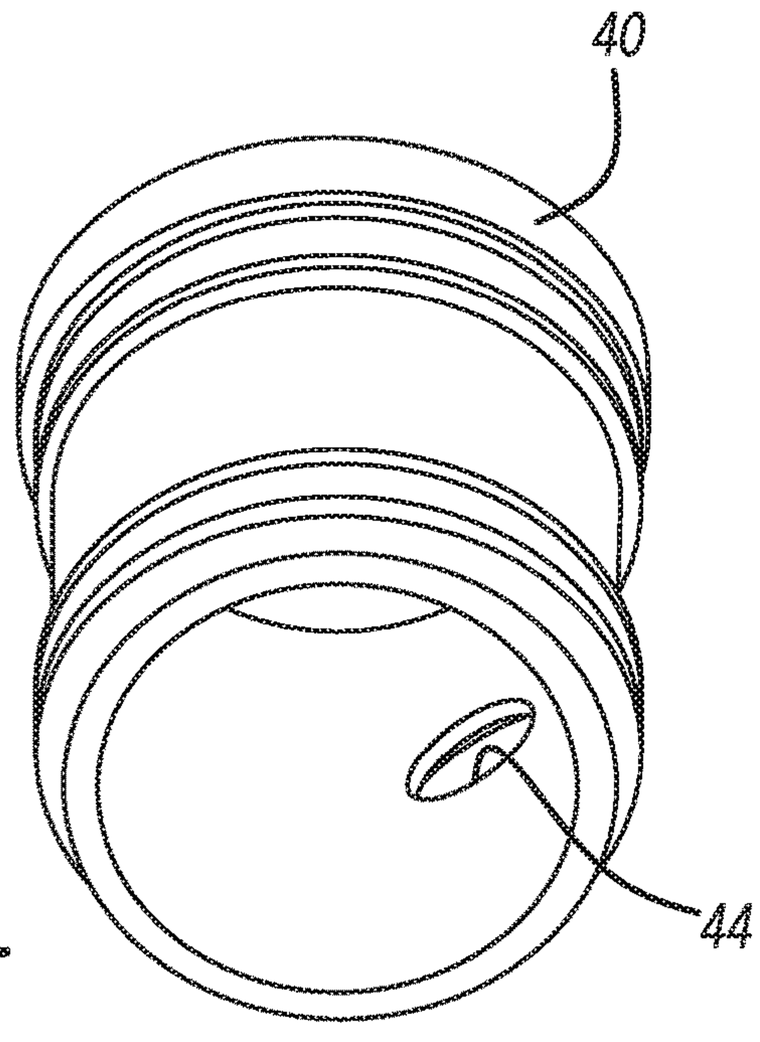

FIG - 3B

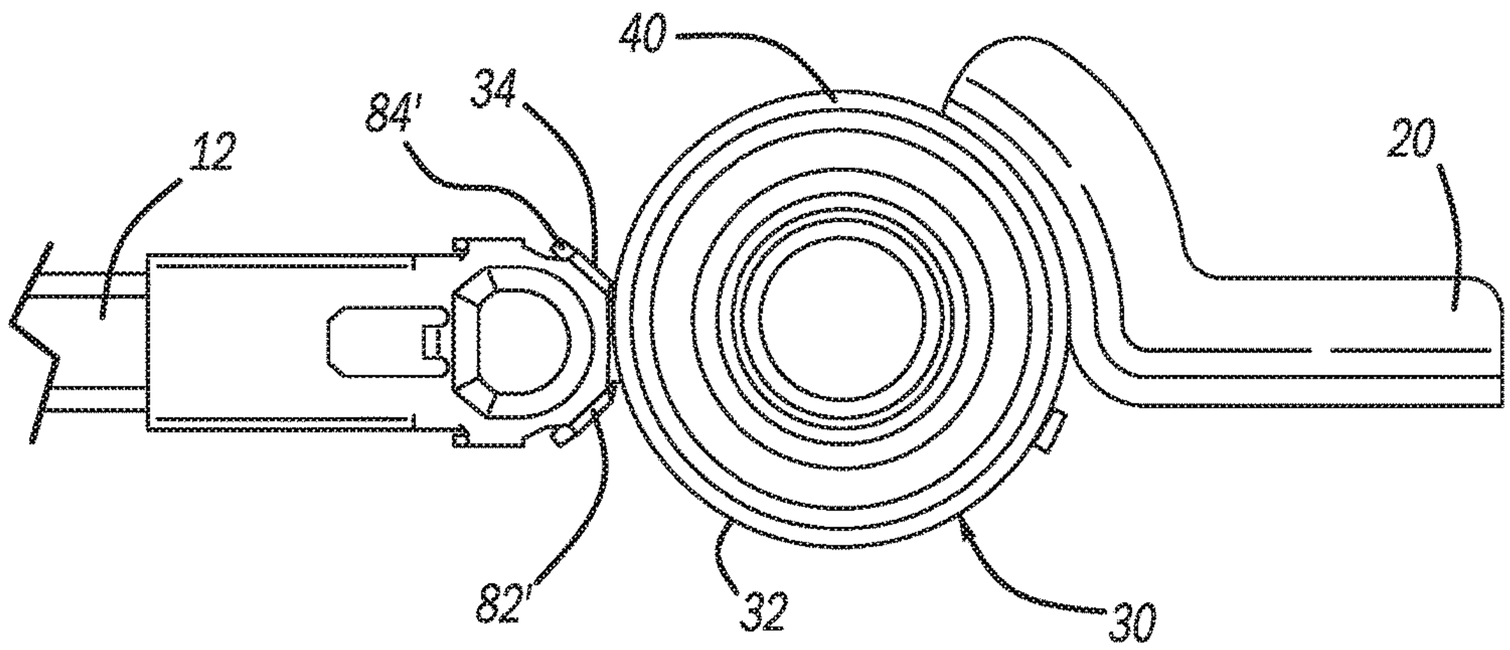

FIG - 4

MODULATOR ASSEMBLY FOR CONDENSER

FIELD

The present disclosure relates to a modulator assembly for a condenser, the modulator assembly including a brazed-in connector and/or a threaded-in connector.

BACKGROUND

This section provides background information related to the present disclosure, which is not necessarily prior art.

Existing condensers include inlet and outlet connectors, which are brazed to one or both header tanks of the condenser. Many existing condensers also have a modulator brazed to one of the header tanks. While existing condenser assemblies are suitable for their intended use, they are subject to improvement. For example, because each brazing is a potential leak path, it would be desirable to reduce the number of brazing connections to the header tanks. The present disclosure advantageously includes a modulator assembly for a condenser that reduces the number of brazing connections to the header tanks of the condenser, thereby reducing the number of potential leak paths. The present disclosure also provides various packaging and production advantages, as one skilled in the art will appreciate.

SUMMARY

This section provides a general summary of the disclosure, and is not a comprehensive disclosure of its full scope or all of its features.

The present disclosure includes a modulator assembly for a condenser. The modulator assembly has a tube having a first end and a second end. A first connector is brazed to the first end of the tube. A second connector is threadably secured at the second end of the tube.

Further areas of applicability will become apparent from the description provided herein. The description and specific examples in this summary are intended for purposes of illustration only and are not intended to limit the scope of the present disclosure.

DRAWINGS

The drawings described herein are for illustrative purposes only of select embodiments and not all possible implementations, and are not intended to limit the scope of the present disclosure.

FIG. **1** illustrates an exemplary condenser and modulator in accordance with the present teachings;

FIG. **2** is a exploded view of an outlet end of the modulator of FIG. **1**;

FIG. **3**A is an exploded view of an inlet end of the modulator of FIG. **1**;

FIG. **3**B is a perspective view of an inlet connector at the inlet end of the modulator; and

FIG. **4** is a top view of the modulator of FIG. **1** connected to a header tank of the condenser of FIG. **1**.

Corresponding reference numerals indicate corresponding parts throughout the several views of the drawings.

DETAILED DESCRIPTION

Example embodiments will now be described more fully with reference to the accompanying drawings.

With initial reference to FIG. **1**, a condenser assembly in accordance with the present disclosure is illustrated at reference numeral **10**. The condenser assembly **10** can be configured for use with any suitable heating, ventilation, and air conditioning (HVAC) system, such as any suitable vehicle HVAC system or non-vehicular HVAC system. The condenser assembly **10** generally includes a condenser **12** and a modulator assembly **30**.

The condenser **12** generally includes a core **14** of refrigerant conduits, which extend between a first header tank **16** and a second header tank **18**. The condenser assembly **10** may include one or more mounting brackets **20** for mounting the condenser assembly **10** at any suitable location. In the example of FIG. **1**, mounting brackets **20** are mounted to the modulator assembly **30** and the second header tank **18**. The mounting brackets **20** may be secured in any suitable manner, such as by brazing.

The modulator assembly **30** includes a tube **32**. The tube **32** can be made of any suitable material, such as aluminum. The tube **32** is secured to the first header tank **16** by brazing at tank mating portions **34** and **36**.

The modulator assembly **30** includes an inlet connector **40**, which is connected to any suitable inlet conduit **42**. Refrigerant flows through the inlet conduit **42** to the inlet connector **40**. From the inlet connector **40**, the refrigerant flows into the condenser **12** through an opening of the first header tank **16**. At the condenser **12**, high pressure gas refrigerant condenses as the refrigerant flows through the core **14**. From the core **14**, the refrigerant flows out of an opening of the first header tank **16**, and back to the modulator assembly **30** by way of the tank mating portion **36** and an outlet connector assembly **50**. Liquid refrigerant flows out of the modulator assembly **30** through an outlet conduit **52**, and any remaining gaseous refrigerant continues to condense within the modulator assembly **30**. After the gaseous refrigerant condenses into liquid refrigerant, it flows out through the outlet conduit **52**. Thus the condenser assembly **10** advantageously radiates heat out of the refrigerant and the HVAC system generally. The condenser assembly **10** can be configured as a three-pass condenser assembly, a one-pass condenser assembly, or any other suitable condenser assembly having any suitable number of passes, such as, but not limited to, passes of any odd number increments.

With continued reference to FIG. **1**, and additional reference to FIG. **2**, the outlet connector assembly **50** will now be described in additional detail. The outlet connector assembly **50** may include a block **60**, which is secured within an outlet end **38** of the tube **32**. The block **60** is secured within the outlet end **38** in any suitable manner, such as by brazing. The block **60** defines an opening **62**, which is aligned with an opening **80** of the tube **32**. The opening **80** is aligned with an outlet opening of the tank **16**. In some applications, the outlet end **38** of the tube **32** is threaded. If the outlet end **38** is threaded, the outlet connector **70** described below may be threadably connected directly to the tube **32**, thus eliminating any need for the block **60**.

The outlet connector assembly **50** further includes the outlet connector **70**. The outlet connector **70** has a plurality of threads **72**, which are configured to cooperate with internal threads of the block **60**. The outlet connector **70** defines an outlet **74**, to which the outlet conduit **52** can be connected to. To provide a seal between the outlet connector **70** and the outlet conduit **52**, one or more seals, such as washers **76**, can be arranged proximate to the outlet **74**. The outlet connector **70** defines an opening **78**, which is aligned with the opening **62** of the block **60** when the outlet

connector **70** is threaded into cooperation with the block **60**. The block **60** and the outlet connector **70** can each be made of any suitable material, such as aluminum.

The threaded connection between the outlet connector **70** and the block **60** advantageously allows the outlet connector **70** to be removably attached to the block **60**. Thus after the block **60** is braised to the tube **32**, the outlet connector **70** may be threadably coupled to, and decoupled from, the block **60** in order to allow a suitable drying agent, such as a desiccant (e.g., desiccant beads) to be added to, or removed from, the modulator assembly **30**. The desiccant absorbs moisture to prevent it from circulating throughout the HVAC system.

The tank mating portion **36** is at the opening **80**, and includes a first leg **82** and a second leg **84** on opposite sides of the opening **80**. The first and second legs **82** and **84** each extend outward, and are generally curved to match an outer radii of the first header tank **16** so that the first and second legs **82** and **84** closely abut the first header tank **16**. A planar surface **86** of the tube **32** extends between the tank mating portion **36** and the tank mating portion **34**, and is shaped to abut a generally planar portion of the first header tank **16**. The tank mating portion **34** is the same as, or substantially similar to, the tank making portion **36**, and thus the illustration and description of the tank mating portion **36** is sufficient to describe the tank mating portion **34**. With regards to FIG. **3**A, the first and second legs of the tank mating portion **34** are illustrated at reference numbers **82'** and **84'**.

With additional reference to FIGS. **3**A, **3**B, and **4**, the inlet connector **40** is illustrated in additional detail. The inlet connector **40** defines an opening **44**, which is aligned with an opening **92** of the tube **32** at the inlet end **90**. The opening **92** is aligned with an inlet opening defined by the first header tank **16**. The inlet connector **40** is secured within the inlet end **90** of the tube **32** in any suitable manner, such as by brazing. Although the inlet connector **40** is described as being brazed at the inlet end **90**, in other applications the inlet connector **40** may be brazed within the outlet end **38**, and the outlet connector assembly **50** may be arranged at the inlet end **90**. In still other applications, both the inlet end **90** and the outlet end **38** may include outlet connector assemblies.

Thus the present disclosure advantageously provides for a modulator assembly **30** as a single sub-assembly having both an inlet connector **40** and an outlet connector assembly **50**, which eliminates any need for separate inlet and outlet connectors to be brazed to the tanks **16**/**18** of the condenser **12**. Reducing the number of brazings to the tanks **16**/**18** advantageously reduces potential leak paths. Providing the modulator assembly **30** as a single subassembly also provides various packaging and production advantages, as one skilled in the art will appreciate. For example, the present disclosure permits a more narrow condenser profile, increased design flexibility, and has few features that may potentially obstruct use of side seals. One skilled in the art will appreciate that the present disclosure provides numerous additional advantages and unexpected results over the art.

The foregoing description of the embodiments has been provided for purposes of illustration and description. It is not intended to be exhaustive or to limit the disclosure. Individual elements or features of a particular embodiment are generally not limited to that particular embodiment, but, where applicable, are interchangeable and can be used in a selected embodiment, even if not specifically shown or described. The same may also be varied in many ways. Such variations are not to be regarded as a departure from the disclosure, and all such modifications are intended to be included within the scope of the disclosure.

Example embodiments are provided so that this disclosure will be thorough, and will fully convey the scope to those who are skilled in the art. Numerous specific details are set forth such as examples of specific components, devices, and methods, to provide a thorough understanding of embodiments of the present disclosure. It will be apparent to those skilled in the art that specific details need not be employed, that example embodiments may be embodied in many different forms and that neither should be construed to limit the scope of the disclosure. In some example embodiments, well-known processes, well-known device structures, and well-known technologies are not described in detail.

The terminology used herein is for the purpose of describing particular example embodiments only and is not intended to be limiting. As used herein, the singular forms "a," "an," and "the" may be intended to include the plural forms as well, unless the context clearly indicates otherwise. The terms "comprises," "comprising," "including," and "having," are inclusive and therefore specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof. The method steps, processes, and operations described herein are not to be construed as necessarily requiring their performance in the particular order discussed or illustrated, unless specifically identified as an order of performance. It is also to be understood that additional or alternative steps may be employed.

When an element or layer is referred to as being "on," "engaged to," "connected to," or "coupled to" another element or layer, it may be directly on, engaged, connected or coupled to the other element or layer, or intervening elements or layers may be present. In contrast, when an element is referred to as being "directly on," "directly engaged to," "directly connected to," or "directly coupled to" another element or layer, there may be no intervening elements or layers present. Other words used to describe the relationship between elements should be interpreted in a like fashion (e.g., "between" versus "directly between," "adjacent" versus "directly adjacent," etc.). As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items.

Although the terms first, second, third, etc. may be used herein to describe various elements, components, regions, layers and/or sections, these elements, components, regions, layers and/or sections should not be limited by these terms. These terms may be only used to distinguish one element, component, region, layer or section from another region, layer or section. Terms such as "first," "second," and other numerical terms when used herein do not imply a sequence or order unless clearly indicated by the context. Thus, a first element, component, region, layer or section discussed below could be termed a second element, component, region, layer or section without departing from the teachings of the example embodiments.

Spatially relative terms, such as "inner," "outer," "beneath," "below," "lower," "above," "upper," and the like, may be used herein for ease of description to describe one element or feature's relationship to another element(s) or feature(s) as illustrated in the figures. Spatially relative terms may be intended to encompass different orientations of the device in use or operation in addition to the orientation depicted in the figures. For example, if the device in the

figures is turned over, elements described as "below" or "beneath" other elements or features would then be oriented "above" the other elements or features. Thus, the example term "below" can encompass both an orientation of above and below. The device may be otherwise oriented (rotated 90 degrees or at other orientations) and the spatially relative descriptors used herein interpreted accordingly.

What is claimed is:

1. A modulator assembly for a condenser, the modulator assembly comprising:

a tube having a first end and a second end, the tube defines an inlet opening proximate to the first end and an outlet opening proximate to the second end, with the tube connected to a tank of the condenser the inlet opening aligns with a tank inlet and the outlet opening aligns with a tank outlet;

a first connector brazed to the first end of the tube, the first connector is configured to direct refrigerant through the inlet opening and the tank inlet into the tank of the condenser; and

a second connector threadably secured at the second end of the tube, the second connector is configured to direct refrigerant out from within the tank and out of the modulator.

2. The modulator assembly of claim **1**, wherein the second connector is threadably coupled to threads at the second end of the tube.

3. The modulator assembly of claim **1**, further comprising a connector assembly at the second end of the tube, the connector assembly including a block brazed to the second end and the second connector threaded into cooperation with the block.

4. The modulator assembly of claim **3**, wherein the tube is extruded aluminum, the first connector includes aluminum, the second connector includes aluminum, and the block includes aluminum.

5. The modulator assembly of claim **3**, wherein the block includes internal threads and the second connector includes external threads configured to mate with the internal threads of the block.

6. The modulator assembly of claim **1**, wherein the first connector is an inlet connector, and the second connector is an outlet connector.

7. The modulator assembly of claim **1**, wherein the first connector is an outlet connector, and the second connector is an inlet connector.

8. The modulator assembly of claim **1**, wherein the tube includes a first tank mating portion proximate to the first end, the first tank mating portion including: a planar surface at an exterior of the tube surrounding the inlet opening; and legs on opposite sides of the planar surface, the legs are curved to match an outer radii of the tank such that the legs mate with the tank.

9. The modulator assembly of claim **1**, wherein the tube includes a second tank mating portion proximate to the second end, the second tank mating portion including: a planar surface at an exterior of the tube surrounding the outlet opening; and legs on opposite sides of the planar surface, the legs are curved to match an outer radii of the tank such that the legs mate with the tank.

10. The modulator assembly of claim **1**, wherein the tube is brazed to the tank at the inlet opening and at the outlet opening.

11. The modulator assembly of claim **1**, further comprising at least one mounting bracket brazed to the tube, and at least one mounting bracket brazed to a header tank at an end of the condenser opposite to the modulator.

12. A condenser assembly comprising:

a condenser including a core, a first tank at a first end of the core, and a second tank at a second end of the core;

a modulator assembly including a tube connected to the first tank such that an outlet opening defined by the tube is aligned with a tank inlet of the first tank, and an inlet opening defined by the tube is aligned with a tank outlet of the first tank;

an inlet connector brazed to a first end of the tube; and

an outlet connector assembly at a second end of the tube, the outlet connector assembly including a block brazed to the second end and a second connector threaded into cooperation with the block.

13. The condenser assembly of claim **12**, wherein the tube is brazed to the first tank at a first interface between the outlet opening and the tank inlet, and at a second interface between the inlet opening and the tank outlet.

14. The condenser assembly of claim **12**, wherein the tube is extruded aluminum, the inlet connector includes aluminum, the outlet connector includes aluminum, and the block includes aluminum.

15. The condenser assembly of claim **12**, wherein the tube includes a first tank mating portion proximate to the first end, the first tank mating portion including: a planar surface at an exterior of the tube surrounding the inlet opening; and legs on opposite sides of the planar surface, the legs are curved to match an outer radii of the tank such that the legs mate with the tank.

16. The condenser assembly of claim **12**, wherein the tube includes a second tank mating portion proximate to the second end, the second tank mating portion including: a planar surface at an exterior of the tube surrounding the outlet opening; and legs on opposite sides of the planar surface, the legs are curved to match an outer radii of the tank.

17. The condenser assembly of claim **12**, wherein the block includes internal threads and the second connector includes external threads configured to mate with the internal threads of the block to removably connect the second connector to the block and allow insertion of a desiccant within the tube.

18. The condenser assembly of claim **12**, further comprising at least one mounting bracket brazed to the tube, and at least one mounting bracket brazed to a header tank at an end of the condenser opposite to the modulator.

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